Comparative morphological study of the male genitalia of Spondylidinae (Coleoptera: Cerambycidae) from China and their significance in taxonomy

Chenli PENG, Zhu LI, Li CHEN①

College of Plant Protection, Southwest University, institute of Entomology, Chongqing 400716, China

Abstract: The male genitalia of four tribes and seven genera in the subfamily Spondylidinae in China are described and compared. Result shows that 18 genital morphologcial characteristics are different within this subfamily. Five differences such as shape of the parameres, ratio of length and width of parameres, shape of tergite VIII, etc., could be used to indentify tribes within the Spondylidinae. Six morphologcial characteristics, such as ratio of parameres and tegmen, shape of roof, curvature of median lobe, etc., could be used to identify genera within the tribe Asemini. Two characteristics, ratio of length and width of parameres and the setation of tergite VIII can be used to identify species in the genus *Cephalallus*. A key to the Chinese tribes of Spondylidinae and the genera of Asemini is presented.

Key words: Chrysomeloidea; longicorn beetles; taxonomy; key

中国椎天牛亚科雄性外生殖器比较形态学研究（鞘翅目：天牛科）及其分类学意义

彭陈丽，李竹，陈力①

西南大学植物保护学院，昆虫研究所，重庆 400716

摘要：描述并比较了中国椎天牛亚科 4 族 7 属的雄性外生殖器结构特点。结果表明：椎天牛亚科内有 18 个雄性外生殖器结构特征存在差异，其中阳基侧突的形状、阳基侧突的长宽比，腹部第 8 节背板的形状等 5 个特征在椎天牛亚科内族级水平具有重要分类学意义；阳基侧突占阳茎的比例，腹部第 8 节背板的被毛情况等 6 个特征在幽天牛族内属级水平具有重要分类学意义；同时阳基侧突的长宽比，腹部第 8 节背板的被毛情况可用于塞幽天牛属中近似种的区分。基于雄性外生殖器的结构，编制了椎天牛亚科分族及幽天牛族分属的检索表。

关键词：叶甲总科；天牛；分类；检索表

Introduction

Spondylidinae Audinet-Serville, 1832 belongs to Insecta, Coleoptera, Cerambycidae. The subfamily accepted here consists of 7 tribes, 32 genera and approximately 160 species worldwide (Danilevsky 2014; Wang 2017), this includes 4 tribes, 8 genera and 32 species presently recorded in China. The first species in this subfamily were recorded by Linnaeus in 1758. By the 1920s, most genera of Spondylidinae had been established. For many genera, the type species were separated from Cerambycinae. The taxon was once divided two distinct subfamilies, Spondylidinae and Aseminae (Napp 1994; Monné 1994; Kusama *et al*. 1984;

Accepted 11 June 2018. Published 25 September 2018. Published online 28 August 2018.

① Corresponding author, E-mail: lichen57@swu.edu.cn

Wang 2002; Özdikmen 2014; Özbek *et al*. 2015). The Aseminae became regarded as a junior synonym of Spondylidinae based on the characters of larva and pupa (Gressitt 1951; Gressitt & Rondon 1970; Cherepanov 1979; Nakamura *et al*. 1992; Althoff & Danilevsky 1997; Serafim 2007; Danilevsky 2014; Klausnitzer *et al*. 2016; Wang 2017). Asemini is the biggest tribe in Spondylidinae. It was established by Thomson in 1861, based on the type genus *Asemum* Eschscholtz, 1830. Up to now, 9 genera and 47 species are recognized as belonging to this tribe worldwide. In China, there are 4 genera and 17 species of Asemini.

The male genitalia of Cerambycidae have been shown by a number of entomologists to provide valuable characters (Ehara 1954; Chen & Wu 1986; Wang 2002; Feng *et al*. 2010; Liu *et al*. 2012; Zhang & Chen 2013; He *et al*. 2015; Ren *et al*. 2016). Most research on Spondylidinae has focused on species description (Thomson 1861; Gahan 1906; Aurivillius 1912; Matsushita 1933; Gressitt 1951; Danilevsky 2014), but there are only a few male genitalia descriptions of several species (Ehara 1954; Shi 2012; Lee *et al*. 2016) published. The value of male genitalia characteristics for tribal and genus identification in Spondylidinae is unclear.

In this work, the male genitalia morphological characteristics of Chinese species in Spondylidinae were compared, and keys to tribes and genera are provided. The systematic relationships among the tribes and genera are also discussed, which suggested that these results generally coincide with the traditional classification of the subfamily.

Material and methods

Specimens

A total of 33 individuals representing 10 species were examined. The materials were mostly provided by the following collections:

SWU — Institute of Entomology, College of Plant Protection, Southwest University, Chongqing, China;

BHU — Beihua University, Jilin, China;

HICIQ — Hainan Entry-Exit Inspection and Quarantine Bureau, Hainan, China;

YAF — Yunnan Academy of Forestry, Yunnan, China.

Table 1. Specimens information for 10 species in Spondylidinae from China

Species	Number	Collection
Cephalallus oberthueri Sharp, 1905	9	SWU
Cephalallus unicolor (Gahan, 1906)	5	SWU
Arhopalus angustus Gressitt, 1951	1	HICIQ
Arhopalus coreanus (Sharp, 1905)	2	BHU
Arhopalus foveatus Chiang, 1963	1	YAF
Arhopalus rusticus (Linnaeus, 1758)	4	SWU, YAF
Asemum striatum (Linnaeus, 1758)	5	BHU, SWU
Megasemum quadricostulatum Kraatz, 1879	2	SWU
Tetropium gracilicorne Reitter, 1889	1	SWU
Spondylis buprestoides (Linnaeus, 1758)	3	SWU,YAF

Methods

The abdomen of each specimen is removed along the joint between the abdomen and metathorax, dissected along the lateral edge with an anatomical scissor, and boiled in 10% NaOH solution for 5–10 minutes in a water bath. Genitalia were extracted from the abdomen, cleared in water, and stored in capsules containing 75% alcohol and a small amount of glycerol (Shi 2012).

Pictures were taken using a stereomicroscope (Leica M205A) and optimized with software Photoshop CC®.

The terminology of male genitalia follows Ślipiński & Escalona (2013), Jiang & Chen (2001) and Ehara (1954). The system of classification adopted here is that of Danilevsky's catalogue (2014).

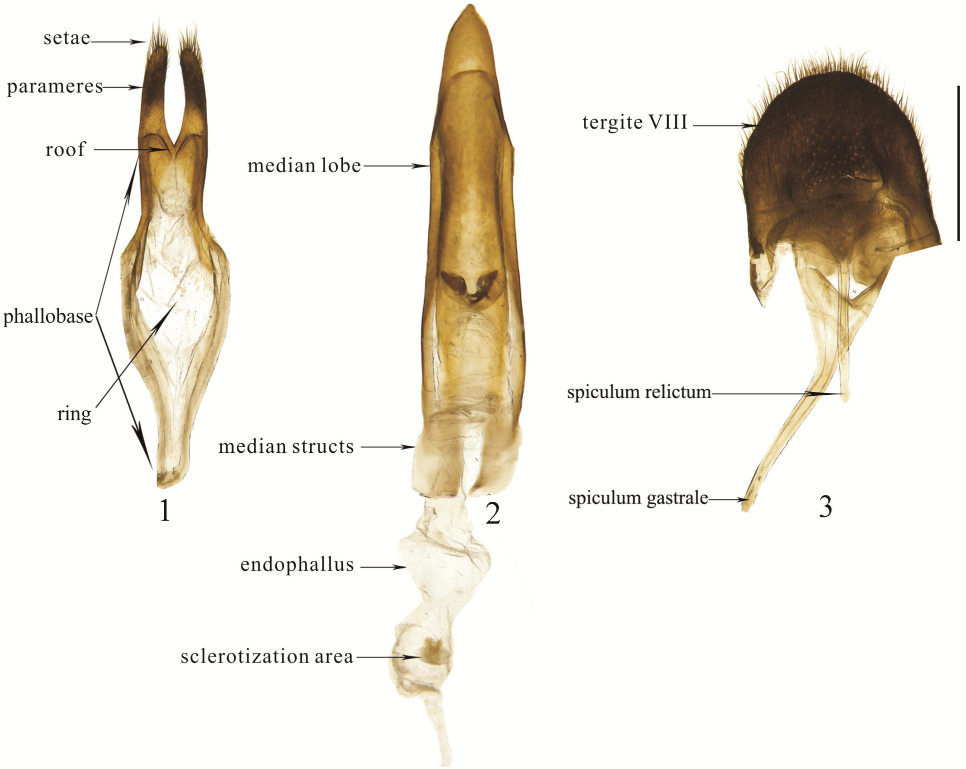


Figure 1–3. Male genitalia of Spondylidinae (*Arhopalus angustus* Gressitt, 1951). 1. Tegmen, ventral view; 2. Penis, ventral view; 3. Abdominal sternum VIII, ventral view. Scale bar = 1 mm.

Results

Spondylidinae Audinet-Serville, 1832

Spondylii, Audinet-Serville 1832: 123.

Description. Body small to moderate size. Head short, tranverse, anteriorly short, never rostrate; mouthparts prognathous. Antennal segments glabrous, 11-segmented, usually short and robust, slightly longer or shorter than body in male, always shorter in female, very short in Spondylidini. Forehead without keels or teeth. Labrum separate but often short and transverse.

Mandibles not chisel-shaped, rounded. Eyes very large (*Pectoctenus*) to very small (*Michthisoma*) (Švácha & Lawrence 2014), more or less emarginate, in some cases strongly constricted or divided into two parts (*Tetropium*). Stridulatory almost always divided in the middle by a longitudinal groove, sometimes absent (*Tetropium*). Pronotum oval to subsquare, without lateral margin. Elytra usually covered with longitudinal carina, normally developed and covering most of the abdomen. Prosternal process present. Procoxal cavities of variable shape, closed internally, open or closed posteriorly; lateral procoxa and trochantin at least partly exposed. Procoxae moderately transverse to subglobular, at most slightly projecting below prosternal process (Švácha & Lawrence 2014). Leg short, anterior tibia with 1 or 2 spurs.

Distribution. All biogeographic regions, mainly in the Northern Hemisphere, predominantly Holarctic (Wang 2017; Švácha & Lawrence 2014). Among the 8 genera recorded in China, only the *Proatimia* are endemic to the Oriental Region; the other 7 are transboundary genera.

Key to Chinese tribes of Spondylidinae based on male genitalia

1. Length of parameres not less than 3.5 times its basal width······································ Asemini
-. Length of parameres less than 3.5 times its basal width······································2
2. Rod at apex of endophallus present······································Atimiini
-. Rod at apex of endophallus absent······································ 3
3. Tergite VIII hexagonal······································ Spondylidini
-. Tergite VIII semi-elliptical······································Tetropiini

Key to Chinese genera of Asemini based on male genitalia

1. Parameres less than 1/4 as long as tegmen······································ *Asemum*
-. Parameres not less than 1/4 as long as tegmen······································2
2. Median lobe bluntly pointed at the apical ventral edge······································ *Megasemum*
-. Median lobe not bluntly pointed at the apical ventral edge······································3
3. Roof absent ventrally, V-shaped dorsally······································ *Arhopalus*
-. Roof short······································*Cephalallus*

Tribe Asemini Thomson, 1861

Asemitæ Thomson, 1861: 259. Type genus: *Asemum* Eschscholtz, 1830.

Genus *Cephalallus* Sharp, 1905

Cephalallus Sharp, 1905: 148. Type species: *Cephalallus oberthueri* Sharp, 1905.

Cephalallus oberthueri Sharp, 1905 (Figs. 4, 14, 24, 34, 44, 54)

Cephalallus oberthüri Sharp, 1905: 148. TL: China, Yunnan. TD: Muséum National d'Histoire Naturelle, Paris.

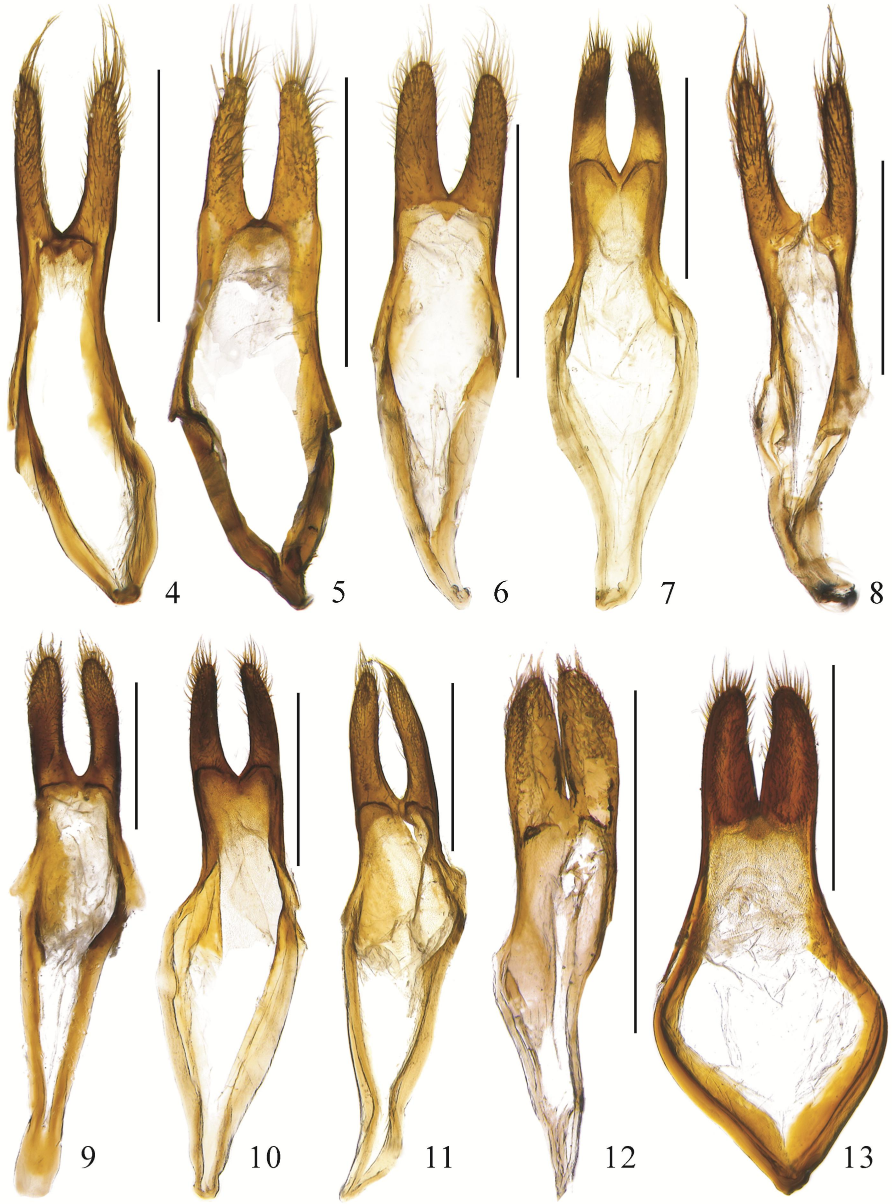
Criocephalus (*Cephalallus*) *oberthuri*, Aurivillius, 1912: 22.

Arhopalus (*Cephalallus*) *oberthuri*, Gressitt, 1951: 37.

Arhopalus oberthuri, Hua, 2002: 196.

Cephalallus oberthueri, Löbl & Smetana, 2010: 138.

Male terminalia. Tegmen slender, slightly curved towards venter. Parameres slender, 1/4 as long as tegmen, with length 4 times its basal width, covered with brown setae, with longer and dense setae apically. Roof absent ventrally, V-shaped dorsally. Ring slightly sclerotized, phallobase narrowed to basal 1/3, expanded at the middle, gradually constricted and closed near apex. Penis slightly curved. Median lobe slightly longer than median struts, strongly pointed at the apical ventral edge. Endophallus moderately thin and long, with a sclerotization area in apical part.



Figures 4–13. Tegmen of Spondylidinae in ventral view. 4. *Cephalallus oberthueri* Sharp, 1905; 5. *Cephalallus unicolor* (Gahan, 1906); 6. *Arhopalus angustus* Gressitt, 1951; 7. *Arhopalus coreanus* (Sharp, 1905); 8. *Arhopalus foveatus* Chiang, 1963; 9. *Arhopalus rusticus* (Linnaeus, 1758); 10. *Asemum striatum* (Linnaeus, 1758); 11. *Megasemum quadricostulatum* Kraatz, 1879; 12. *Tetropium gracilicorne* Reitter, 1889; 13. *Spondylis buprestoides* (Linnaeus, 1758). Scale bars = 1 mm.

Tergite VIII ligulate, concave apically, slightly longer than wide, about 6/5 as long as wide; covered with sparse short brown setae laterally, denser and longer apically, longest in the dent. Spiculum gastrale nearly as long as tergite VIII, more than two times as long as spiculum relictum.

Distribution. China (Zhejiang, Fujian, Jiangxi, Hubei, Guangxi, Chongqing, Yunnan, Xizang, Taiwan); India (AR).

Specimens examined. 1♂, **China,** Chongqing, Simian Mountain, Dahonghai, 10-VII-2008, leg. Li CHEN (SWU); 1♂, **China,** Zhejiang, Yuyao, 31-VII–1-VIII-2016, leg. Zhu LI & Chenglong REN (SWU); 1♂, **China,** Xizang, Linzhi, Motuo, elev. 2100 m, 07-VII-2017, leg. Zhiwei DONG (Zhiwei DONG donate to SWU); 1♂, **China,** Xizang, Linzhi, Motuo, elev. 2100 m, 17-VIII-2017, leg. Jianyue QIU, Chenli PENG & Hao XU (SWU); 1♂, same data but 15-VIII-2017; 1♂, same data but 23-VIII-2017; 1♂, **China,** Xizang, Bomi, Tongmai, elev. 1800 m, 11-VIII-2017, leg. Jianyue QIU, Chenli PENG & Hao XU (SWU); 2♂, same data but 13-VIII-2017.

Cephalallus unicolor **(Gahan, 1906)** (Figs. 5, 15, 25, 35, 45, 55)

Criocephalus unicolor Gahan, 1906: 97. TL: India (Assam). TD: The Natural History Museum, London.

Megasemum projectum Okamoto, 1927: 63.

Male terminalia. Tegmen slender, moderately curved towards venter. Parameres slender, 1/4 as long as tegmen, with length about 5 times its basal width, covered with brown setae, with longer and denser setae apically. Roof absent ventrally, V-shaped dorsally. Ring moderately sclerotized, phallobase narrowed to basal 1/3, expanded at the middle, gradually constricted and closed near apex. Penis slightly curved. Median lobe slightly longer than median struts, strongly pointed at the apical ventral edge. Endophallus moderately thin and long, with a sclerotization area in apical part.

Tergite VIII ligulate, concave apically, slightly longer than wide, about 11/10 as long as wide; covered with sparse short brown setae laterally, denser and longer apically. Spiculum gastrale slightly longer than tergite VIII, more than two times as long as spiculum relictum.

Distribution. China (Jilin, Jiangsu, Zhejiang, Fujian, Jiangxi, Henan, Hubei, Hunan, Guangdong, Hainan, Chongqing, Sichuan, Guizhou, Yunnan, Hongkong, Taiwan); Mongolian Plateau; Korea; Japan; Laos; India (Assam: North Khasi Hills); Myanmar.

Specimens examined. 1♂, **China,** Chongqing, Jiangjin, Simian Mountain, 14-VII-2006, leg. Yaqin SONG (SWU); 1♂, **China,** Chongqing, Beibei, Southwest University (SWU); 1♂, **China,** Chongqing, Banan, Ersheng Town, 01-VI-2016, leg. Chenglong REN (SWU); 1♂, **China,** Zhejiang, Yuyao, Siming Mountain, 31-VII-2016, leg. Zhu LI & Chenglong REN (SWU); 1♂, **China,** Hainan, Yinggezui, 14-IV-2016, leg. Jianyue QIU & Xiaoyan YAN (SWU).

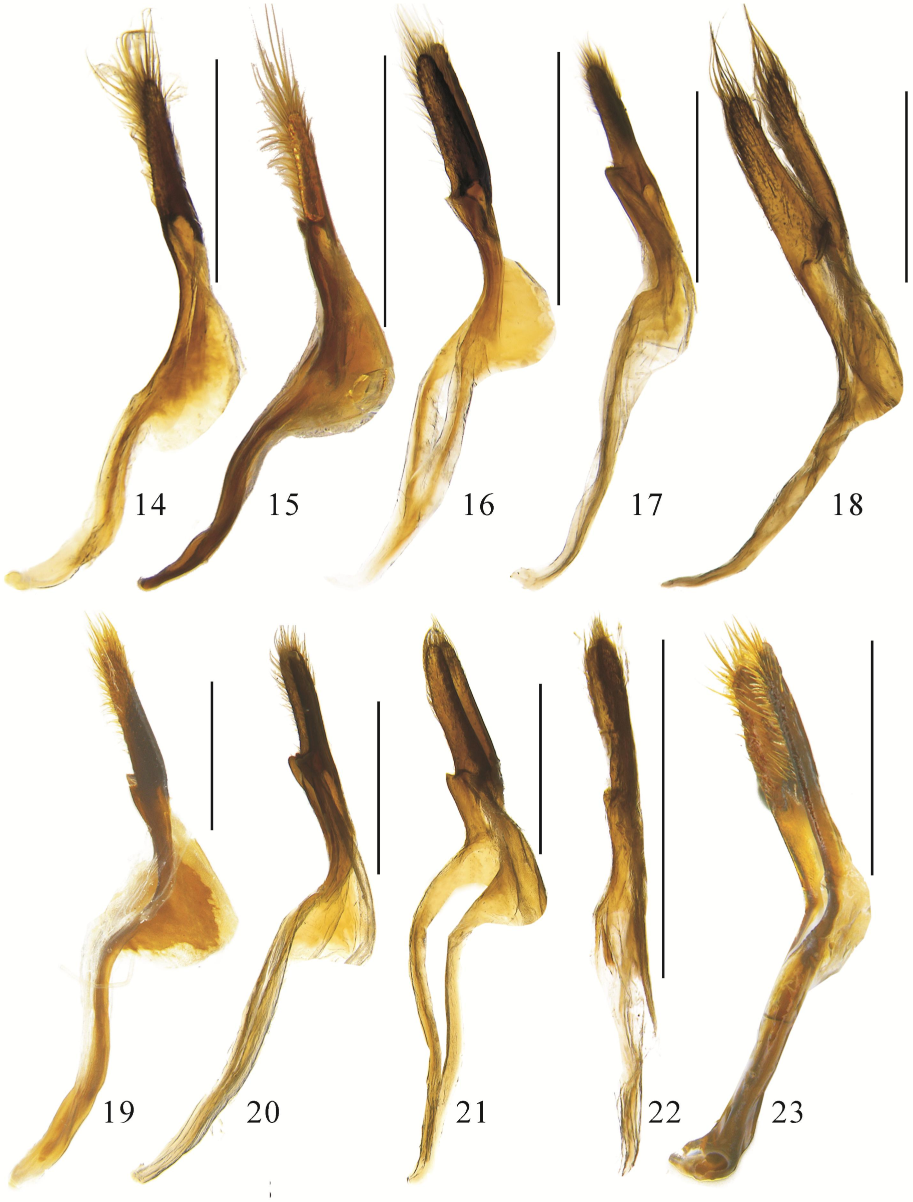
Genus *Arhopalus* Audinet-Serville, 1834

Arhopalus Audinet-Serville, 1834: 77. Type species: *Cerambycx rusticus* Linnaeus, 1758.

Arhopalus angustus **Gressitt, 1951** (Figs. 6, 16, 26, 36, 46, 56)

Arhopalus (*Cephalocrius*) *angustus* Gressitt, 1951: 36. TL: China, Shanghai. TD: Institute of Zoology, Chinese Academy of Sciences, Beijing.

Arhopalus angustus, Hua, 2002: 196.



Figures 14–23. Tegmen of Spondylidinae, lateral view. 14. *Cephalallus oberthueri* Sharp, 1905; 15. *Cephalallus unicolor* (Gahan, 1906); 16. *Arhopalus angustus* Gressitt, 1951; 17. *Arhopalus coreanus* (Sharp, 1905); 18. *Arhopalus foveatus* Chiang, 1963; 19. *Arhopalus rusticus* (Linnaeus, 1758); 20. *Asemum striatum* (Linnaeus, 1758); 21. *Megasemum quadricostulatum* Kraatz, 1879; 22. *Tetropium gracilicorne* Reitter, 1889; 23. *Spondylis buprestoides* (Linnaeus, 1758). Scale bars = 1 mm.

Male terminalia. Tegmen slender, slightly curved towards venter. Parameres slender, 3/10 as long as tegmen, with length 3 times its basal width, covered with brown setae, with longer and dense setae apically. Roof very short ventrally, V-shaped dorsally. Ring slightly sclerotized, phallobase nearly parallel at basal 1/3, expanded backward, gradually constricted after middle and closed to apex. Penis slightly curved. Median lobe nearly as long as median struts, weekly pointed at the apical ventral edge. Endophallus moderately robust.

Tergite VIII ligulate, distinctly concave apically, nearly as long as wide; covered with long dark brown setae laterally, denser and longer apically. Spiculum gastrale slightly longer than tergite VIII, about 1.1 times as long as tergite VIII, less than two times as long as spiculum relictum.

Distribution. China (Shanghai, Jiangsu, Hainan).

Specimen examined. 1♂, **China,** Hainan, Changjiang, Bawangling, 07-IV-1997 (HICIQ).

***Arhopalus coreanus* (Sharp, 1905)** (Figs. 7, 17, 27, 37, 47, 57)

Criocephalus coreanus Sharp, 1905: 153. TD: Korea. TL: The Natural History Museum, London.

Criocephalus (*Criocephalus*) *coreanus*, Aurivillius, 1912: 20; Matsushita, 1933: 237.

Arhopalus (*Arhopalus*) *coreanus*, Gressitt, 1951: 34.

Arhopalus coreanus, Hua, 2002: 196.

Male terminalia. Tegmen slender, slightly curved towards venter. Parameres slender, 3/11 as long as tegmen, with length 5 times its basal width, covered with brown setae, with longer and dense setae apically. Roof short; Ring slightly sclerotized, phallobase narrowed to basal 1/4, slightly geniculate constriction, expanded to the middle, gradually constricted after middle, and distinctly constricted to closed near apex. Penis moderaterly curved. Median struts 5 times longer than median lobe, weekly pointed at the apical ventral edge. Endophallus moderately thin, with a sclerotization area in apical part.

Tergite VIII ligulate, concave round apically, 1.5 times as long as wide; covered with short dark brown setae laterally and apically. Spiculum gastrale slightly longer than tergite VIII, about 1.1 times as long as tergite VIII, less than two times as long as spiculum relictum.

Distribution. China (Northeast Territory); Korea; Japan.

Specimens examined. 2♂, **China,** Jilin, Jiaohe, 03-VI-2016 (BHU).

***Arhopalus foveatus* Chiang, 1963** (Figs. 8, 18, 28, 38, 48, 58)

Arhopalus (*Cephalocrius*) *foveatus* Chiang, 1963: 64, 72. TL: China, Yunnan. TD: Institute of Zoology, Chinese Academy of Sciences, Beijing.

Male terminalia. Tegmen slender, moderately curved towards venter. Parameres 3/11 as long as tegmen, with length about five times its basal width, covered with brown setae, with longer and denser setae apically. Roof very short; Ring slightly sclerotized. Phallobase narrowed from base, constricted and closed at apical 1/4. Penis moderatey curved. Median lobe nearly as long as median struts, strongly pointed at the apical ventral edge. Endophallus very robust and long, with a sclerotization area in apical part.

Tergite VIII ligulate, intensively concave apically, about 8/7 as long as wide; covered with long dark brown setae laterally and apically, denser apically. Spiculum gastrale slightly longer than tergite VIII, nearly 1.2 times as long as tergite VIII, less than two times as long as spiculum relictum.

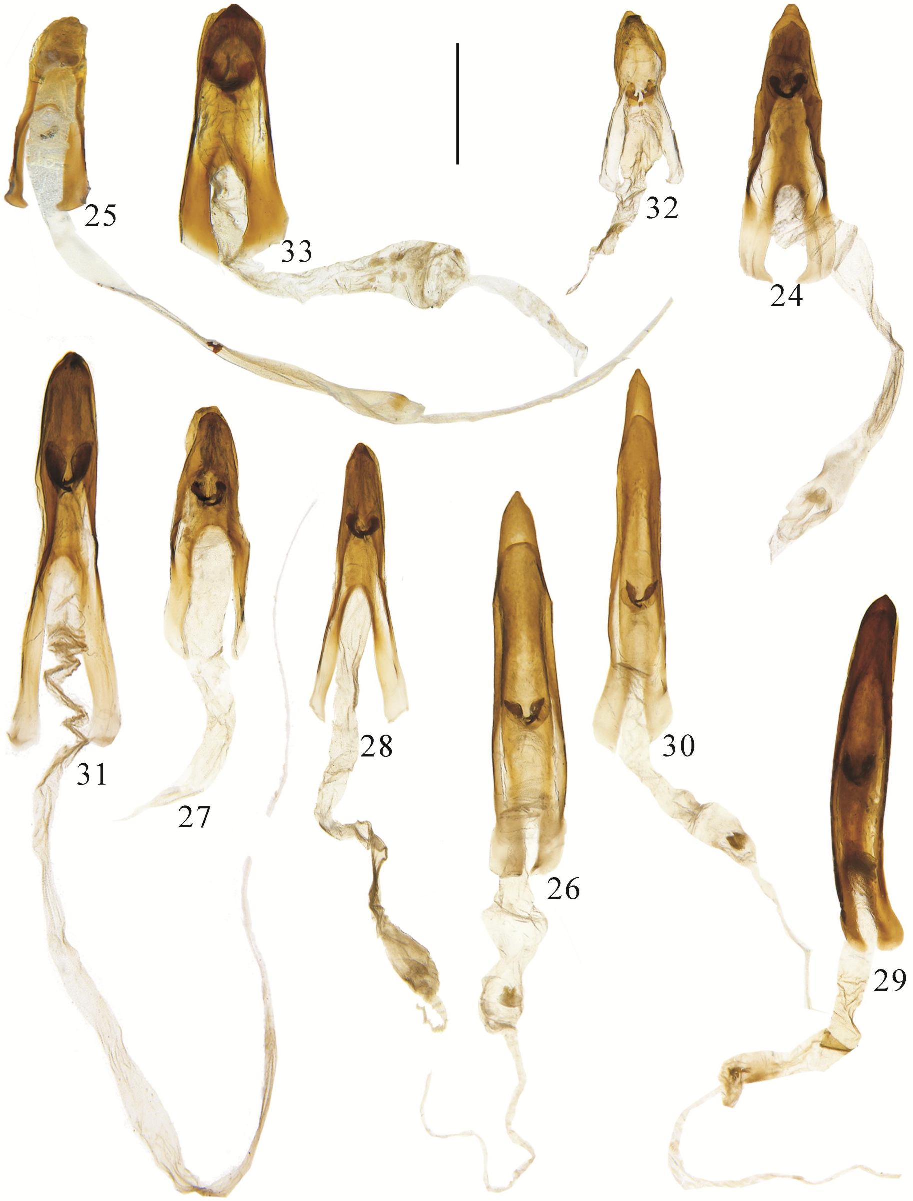
Distribution. China (Fujian, Yunnan, Xizang).

Specimen examined. 1♂, **China,** Yunnan, Xijiekou, 25-IV-2017 (YAF).

***Arhopalus rusticus* (Linnaeus, 1758)** (Figs. 9, 19, 29, 39, 49, 59)

Cerambyx rusticus Linnaeus, 1758: 395. TL: Sweden. TD: Zoologiska Institutionen, Uppsala.

Callidium tristis Fabricius, 1787: 154.
Criocephalum coriaceus Motschulsky, 1845: 89.
Cerambyx lugubris Gmelin, 1790: 1847.
Criocephalus pachymerus Mulsant, 1839: 64.
Criocephalus hispanicus Sharp, 1905: 157.



Figures 24–33. Penis of Spondylidinae, ventral view. 24. *Cephalallus oberthueri* Sharp, 1905; 25. *Cephalallus unicolor* (Gahan, 1906); 26. *Arhopalus angustus* Gressitt, 1951; 27. *Arhopalus coreanus* (Sharp, 1905); 28. *Arhopalus foveatus* Chiang, 1963; 29. *Arhopalus rusticus* (Linnaeus, 1758); 30. *Asemum striatum* (Linnaeus, 1758); 31. *Megasemum quadricostulatum* Kraatz, 1879; 32. *Tetropium gracilicorne* Reitter, 1889; 33. *Spondylis buprestoides* (Linnaeus, 1758). Scale bar = 1 mm.

Male terminalia. Tegmen slender, slightly curved towards venter. Parameres slender, 1/4 as long as tegmen, with length 4 times its basal width, covered with brown setae, with longer and denser setae apically. Roof very short. Ring moderately sclerotized, with geniculate constriction at basal 1/3. Phallobase nearly parallel at basal 1/6, weakly expanded at basal 1/3, gradually constricted and closed near apex. Penis slightly curved. Median lobe much longer than median struts, about 3 times as long as median struts, weakly pointed at the apical ventral edge. Endophallus moderately robust and long, with a sclerotization area in apical part.

Tergite VIII ligulate, round apically, slightly longer than wide, about 7/6 as long as wide; covered with sparse short brown setae laterally, denser and longer apically. Spiculum gastrale nearly 1.3 times as long as tergite VIII, nearly three times as long as spiculum relictum.

Distribution. China (Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Zhejiang, Fujian, Jiangxi, Shandong, Henan, Hubei, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu); Russia (Far East); North Korea; South Korea; Japan; Tajikistan; Kazakhstan; Turkey; Georgia; Russia (Europe); Europe; Morocco; Bulgaria; Ethiopia; America; Australia (introduced).

Specimens examined. 1♂, **China,** Yunnan, Kunming, Shilin, elev. 1500–1900 m, VII-2017 (YAF); 2♂, **China,** Yunnan, Yiliang, VIII-2017 (YAF); 1♂, **China,** Hebei, Xiong Town, elev. 1700 m, 23-V-1980, leg. Qingli XIONG (SWU).

Genus *Asemum* Eschscholtz, 1830

Asemum Eschscholtz, 1830: 66. Type species: *Cerambyx striatus* Linnaeus, 1758.

Asemum striatum (Linnaeus, 1758) (Figs. 10, 20, 30, 40, 50, 60)

Cerambyx striatus Linnaeus, 1758: 396. TL: Sweden. TD: Zoologiska Institutionen, Uppsala.
Callidium agreste Fabricius, 1787: 152.
Cerambyx dichroum Gmelin, 1790: 1846.
Asemum atrum Eschscholtz, 1830: 66.
Asemum brunneum Haldeman, 1847: 35.
Asemum fuscum Haldeman, 1847: 36.
Asemum moestum Haldeman, 1847: 35.
Asemum juvencum Haldeman, 1847: 36.
Asemum mœstum var. *obsoletum* Haldeman, 1847: 35.
Asemum substriatum Haldeman, 1847: 36.
Asemum subsulcatum Motschulsky, 1860: 152.
Asemum amurense Kraatz, 1879: 97.
Asemum curtipenne Casey, 1912: 258.
Asemum ebenum Casey, 1912: 258.
Asemum fulvipenne Casey, 1912: 260.
Asemum gracilicorne Casey, 1912: 258.
Asemum amputatum Casey, 1912: 259.
Asemum costulatum Casey, 1912: 260.
Asemum parvicorne Casey, 1912: 260.
Asemum pugetanum Casey, 1912: 261.
Asemum brevicorne Casey, 1912: 261.
Asemum amurense var. *tomentosum* Plavilstshikov, 1915: 108.
Asemum striatum v. *limbatipenne* Pic, 1916: 10.

Asemum carolinum Casey, 1924: 227.

Asemum stocktonense Casey, 1924: 227.

Asemum striatum japonicum Matsushita, 1933: 235.

Male terminalia. Tegmen slender, moderately curved towards venter. Parameres 1/5 as long as tegmen, with length about 3.6 times its basal width, covered with brown setae, with longer and denser setae apically. Roof absent; Ring slightly sclerotized, phallobase narrowed to basal 1/4, expanded backwards, widest at the middle, gradually constricted and closed at apical 1/5. Penis moderatey curved. Median lobe 1/5 as long as median struts, sharply pointed at the apical ventral edge. Endophallus moderately robust and long.

Tergite VIII ligulate, nearly truncate apically, slightly longer than wide, about 7/6 as long as wide; covered with short brown setae laterally and apically, denser apically, almost the same length apically. Spiculum gastrale slightly longer than tergite VIII, nearly 5/4 as long as tergite VIII, hardly two times as long as spiculum relictum, with a sclerotization area in apical part.

Distribution. China (Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Zhejiang, Shandong, Sichuan, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang); Mongolia; Russia (Far East); North Korea; South Korea; Japan; Kyrgyzstan; Kazakhstan; Turkey; Georgia; Russia (Europe); Europe; Bulgaria; Ethiopia; America; Australia.

Specimens examined. 1♂, **China,** Shanxi, Ningxi, VII-1980, *Pinus armandi* (SWU); 1♂, **China,** Jilin, Jiaohe, Houshan, 17-VI-2016(BHU); **China,** Jilin, 13-VI-2015 (BHU); 2♂, **China,** Jilin, Mopan Mountain, 05-VI-2012, leg. Forestry, Grade 09 (BHU).

Genus *Megasemum* Kraatz, 1879

Type species: *Megasemum quadricostulatum* Kraatz, 1879.

Megasemum Kraatz, 1879: 97. Type species: *Megasemum quadricostulatum* Kraatz, 1879.

***Megasemum quadricostulatum* Kraatz, 1879** (Figs. 11, 21, 31, 41, 51, 61)

Megasemum quadricostulatum Kraatz, 1879: 98. TL: Russia. TD: Senckenberg Deutsches Entomologisches Institut, Müncheberg.

Megasemum 4-costulatum v. *Brevior* Pic, 1901: 11.

Male terminalia. Tegmen slender, moderately curved towards venter. Parameres 1/5 as long as tegmen, with length about four times its basal width, covered with brown setae, with longer and denser setae apically. Roof short. Ring slightly sclerotized, with horny projection at the base, phallobase narrowed to basal 1/7, expanded before middle, gradually constricted after middle and closed at apex. Penis moderatey curved. Median lobe 1/3 as long as median struts, bluntly pointed at the apical ventral edge; Endophallus moderately robust and long.

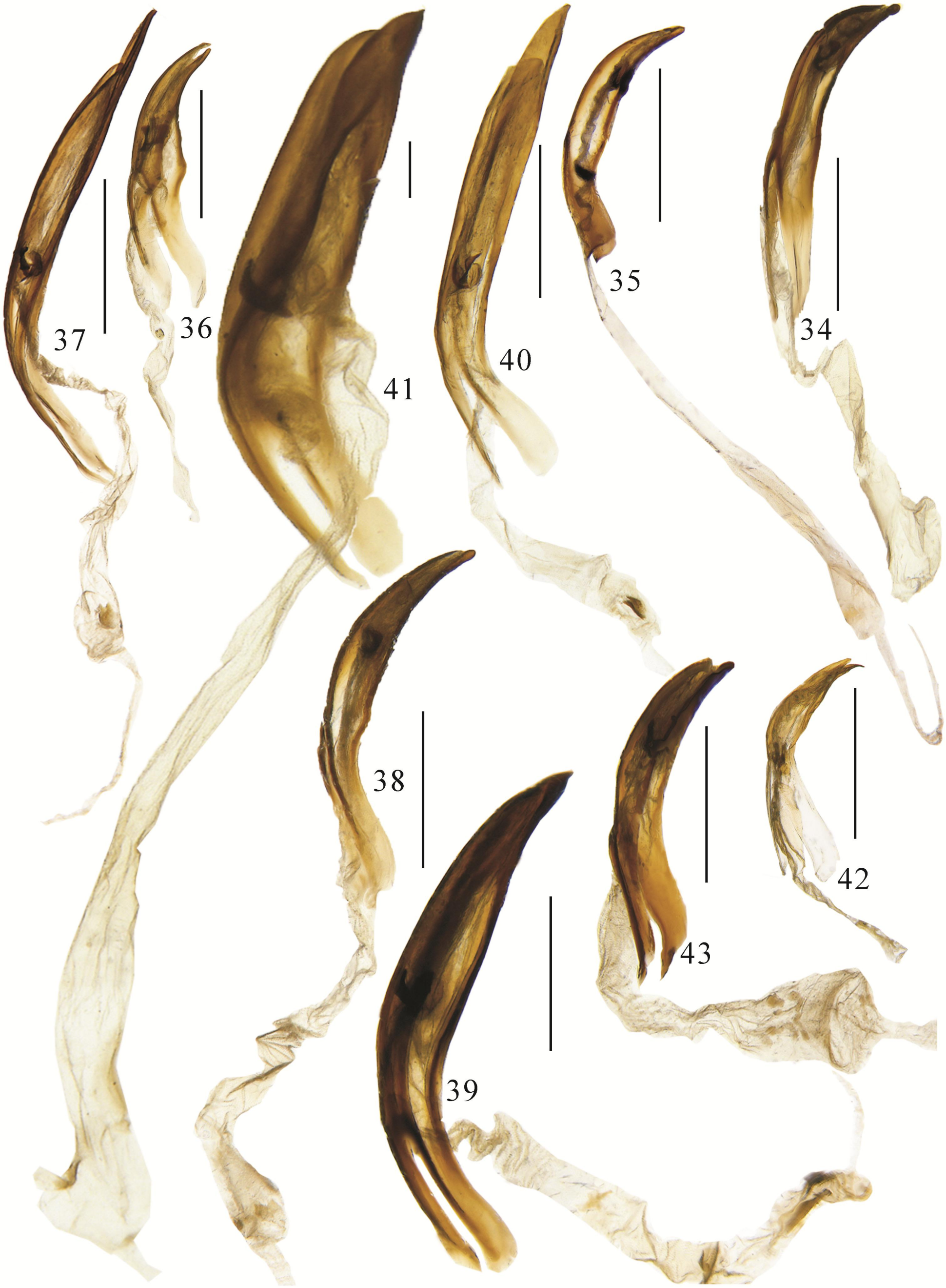
Tergite VIII triangular, rounded apically, nearly as long as wide; covered with short brown setae laterally and apically, denser apically. Spiculum gastrale weekly longer than tergite VIII, two times as long as spiculum relictum.

Distribution. China (Heilongjiang, Fujian, Jiangxi, Hubei, Xizang, Shaanxi, Taiwan); Russia; Korea; Japan.

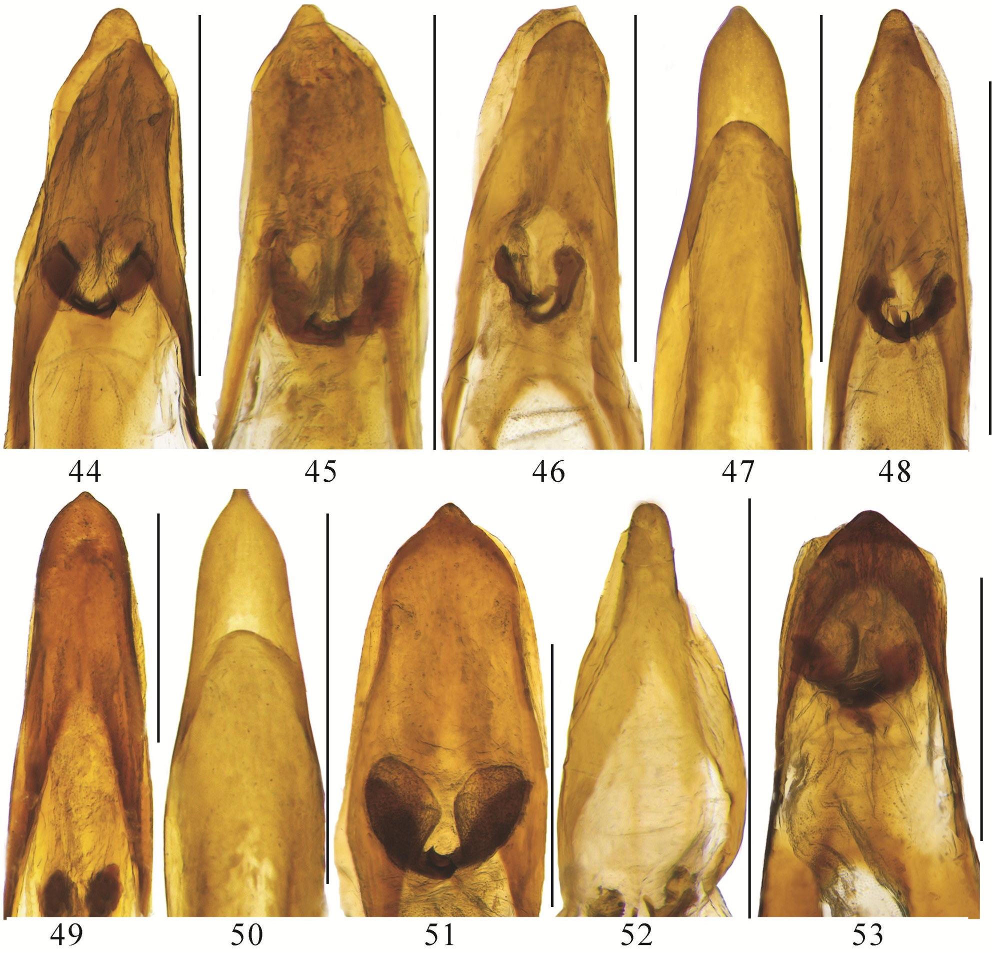
Specimens examined. 1♂, **China,** Shaanxi, Hanzhong, 18-VIII-1981 (SWU); 1♂, **China,** Xizang (Hao XU donate to SWU).

Tribe Tetropiini Seidlitz, 1891

Tetropiina Seidlitz, 1891: 179. Type genus: *Tetropium* Kirby, 1837.



Figures 34–43. Penis of Spondylidinae, lateral view. 34. *Cephalallus oberthueri* Sharp, 1905; 35. *Cephalallus unicolor* (Gahan, 1906); 36. *Arhopalus angustus* Gressitt, 1951; 37. *Arhopalus coreanus* (Sharp, 1905); 38. *Arhopalus foveatus* Chiang, 1963; 39. *Arhopalus rusticus* (Linnaeus, 1758); 40. *Asemum striatum* (Linnaeus, 1758); 41. *Megasemum quadricostulatum* Kraatz, 1879; 42. *Tetropium gracilicorne* Reitter, 1889; 43. *Spondylis buprestoides* (Linnaeus, 1758). Scale bars = 1 mm.



Figures 44–53. Median lobe of Spondylidinae, ventral view. 44. *Cephalallus oberthueri* Sharp, 1905; 45. *Cephalallus unicolor* (Gahan, 1906); 46. *Arhopalus angustus* Gressitt, 1951; 47. *Arhopalus coreanus* (Sharp, 1905); 48. *Arhopalus foveatus* Chiang, 1963; 49. *Arhopalus rusticus* (Linnaeus, 1758); 50. *Asemum striatum* (Linnaeus, 1758); 51. *Megasemum quadricostulatum* Kraatz, 1879; 52. *Tetropium gracilicorne* Reitter, 1889; 53. *Spondylis buprestoides* (Linnaeus, 1758). Scale bars = 1 mm.

Genus *Tetropium* Kirby, 1837

Callidium (*Tetropium*) Kirby, 1837: 174. Type species: *Callidium* (*Tetropium*) *cinnamopterum* Kirby, 1837.

Tetropium gracilicorne **Reitter, 1889** (Figs. 12, 22, 32, 42, 52, 62)

Tetropium gracilicorne Reitter, 1889: 287. TL: Russia. TD: Magyar Természettudományi Mûzeum, Budapest.

Tetropium gracilicorne v. *altaiensis* Pic, 1902: 9.

Tetropium gracilicorne v. *rubripes* Pic, 1902: 9.

Male terminalia. Tegmen slender, moderately curved towards venter. Parameres robust, 3/11 as long as tegmen, with length about 1.3 times its basal width, covered with brown setae, with longer and denser setae apically. Roof short. Ring slightly sclerotized. Phallobase expanded from base 1/5, constricted backward and closed at apical 1/4. Penis moderatey curved. Median lobe slightly longer than median struts, strongly pointed at the apical ventral edge, median struts weakly sclerotized. Endophallus very robust and long.

Tergite VIII semi-elliptical, parallel laterally, rounded apically, about 4/3 as long as wide; covered with short dark brown setae laterally and apically, denser apically. Spiculum gastrale nearly as long as tergite VIII, more than two times as long as spiculum relictum..

Distribution. China (Inner Mongolia, Northeast Territory, Xinjiang); Mongolia; Russia; Korea; Japan; Kazakhstan.

Specimen examined. 1♂, **China,** Jilin, Yunling North, 03-VII-2004, leg. Wentao GAO (BHU).

Tribe Spondylidini Audinet-Serville, 1832

Spondylii Audinet-Serville, 1832: 123. Type genus: *Spondylis* Fabricius, 1775.

Genus *Spondylis* Fabricius, 1775: 15

*Spondylis*Fabricius, 1775: 159. Type species: *Attelabus buprestoides* Linnaeus, 1758.

Spondylis buprestoides (Linnaeus, 1758) (Figs. 13, 23, 33, 43, 53, 63)

Attelabus Buprestoides Linnaeus, 1758: 388. TL: Europe. TD: unknown.

*Cerambyx maxillosu*s DeGeer, 1775: 84.

Spondylis elongatum Latreille, 1829: 107.

Spondylis sinensis Nonfried, 1892: 85, 92.

Spondylis buprestoides var. *Zwergi* Bodemeyer, 1927: 43.

Male terminalia. Tegmen robust and stout, moderately curved towards venter. Parameres 2/7 as long as tegmen, with length 3 times its basal width, covered with brown setae, with longer and denser setae apically. Roof slightly differentiated. Ring moderately sclerotized, nearly heptagon-shaped. Phallobase gradually expanded after middle, widest at apical 1/3, constricted and closed to apex. Penis moderately curved. Median lobe much longer than median struts, about twice as long as median struts, bluntly pointed at the apical ventral edge. Endophallus moderately robust and long.

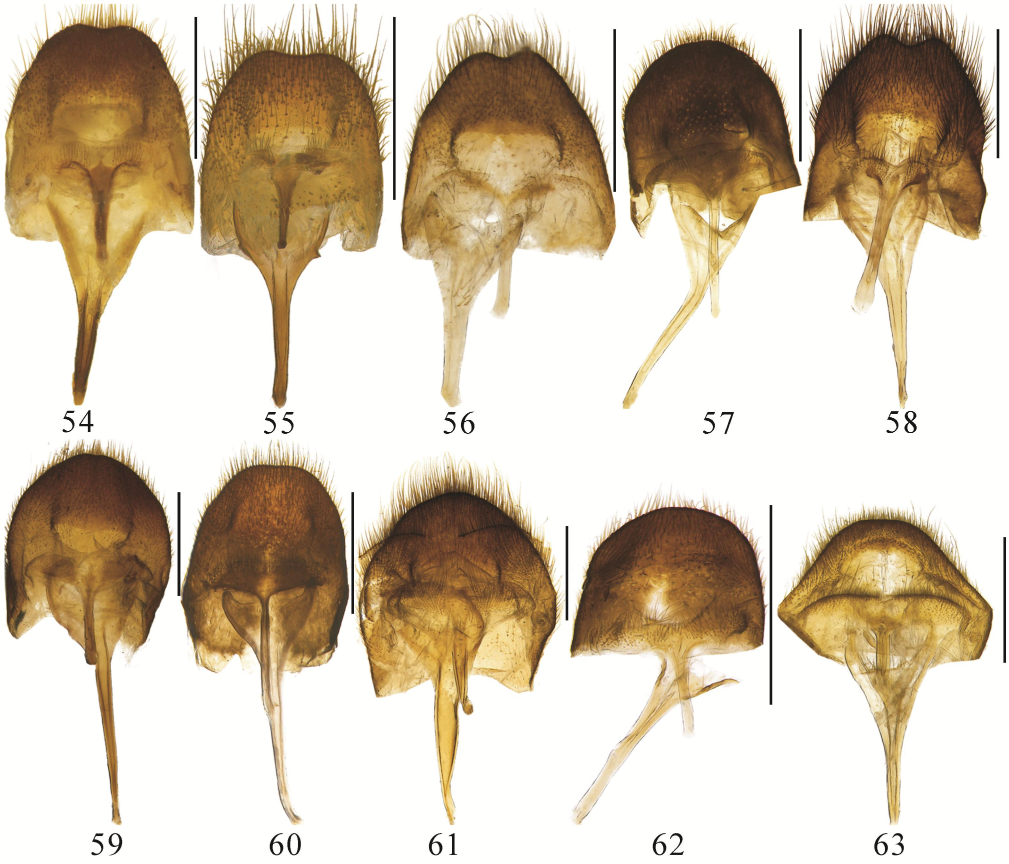
Tergite VIII hexagon, nearly truncate apically, slightly longer than wide, about 9/11 as long as wide; covered with short dense brown setae laterally and apically. Spiculum gastrale slightly longer than tergite VIII, nearly 7/6 as long as tergite VIII, three times as long as spiculum relictum.

Distribution. China (Beijing, Hebei, Inner Mongolia, Heilongjiang, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Henan, Hubei, Hunan, Guangdong, Sichuan, Guizhou, Yunnan, Shaanxi, Taiwan, Hongkong); Mongolia; Russia (Far East); North Korea; South Korea; Japan; Kazakhstan; Turkey; Azerbaijan; Georgia; Russia (Europe); Europe; Egypt; Morocco; Bulgaria; Austria.

Specimens examined. 1♂, **China,** Chongqing, Banan, East hot spring, 01-VI-2016, leg. Chenglong REN (SWU); 2♂, **China,** Yunnan, Kunming, Shilin, elev. 1500–1900 m, VII-2017 (YAF).

Tribe Atimiini LeConte, 1873

Atimiini LeConte, 1873: 322. Type genus: *Atimia* Haldeman, 1847.



Figures 54–63. Teminalia of Spondylidinae, lateral view. 54. *Cephalallus oberthueri* Sharp, 1905; 55. *Cephalallus unicolor* (Gahan, 1906); 56. *Arhopalus angustus* Gressitt, 1951; 57. *Arhopalus coreanus* (Sharp, 1905); 58. *Arhopalus foveatus* Chiang, 1963; 59. *Arhopalus rusticus* (Linnaeus, 1758); 60. *Asemum striatum* (Linnaeus, 1758); 61. *Megasemum quadricostulatum* Kraatz, 1879; 62. *Tetropium gracilicorne* Reitter, 1889; 63. *Spondylis buprestoides* (Linnaeus, 1758). Scale bars = 1 mm.

Genus *Atimia* Haldeman, 1847

Atimia Haldeman, 1847: 56. Type species: *Atimia tristis* Haldeman, 1847 (= *Clytus confusus* Say, 1827).

Atimia nadezhdae Tsherepanov, 1973

Atimia nadezhdae Tsherepanov, 1973: 80. TL: Russia. TD: Siberian Zoological Museum, Institute of Animal Systematic and Ecology of Animals, Novosibirsk.

Male terminalia. Tegmen robust and stout, slightly curved towards venter. Parameres very robust, 1/3 as long as tegmen, with length 3 times its basal width, covered with sparse light brown setae apically. Roof distinct, short. Ring slightly sclerotized, phallobase parallel at basal 1/3, constricted and closed to apex. Penis moderately curved. Median lobe nearly 3 times as long as median struts, strongly pointed at the apical ventral edge. Endophallus moderately robust, with a long rod apically.

Distribution. Korea; Russia (Far East).

Note. No specimens of this tribe have been collected on the Chinese Mainland for a long time due to its rarity and special habit. The characteristics of a foreign species was cited from the publication *A New Record of the Tribe Atimiini LeConte* (*Coleoptera: Cerambycidae: Aseminae*) *in Korea* (Lee *et al.* 2016) in order to compare the characteristics of the subfamily.

Comparative morphology

18 genital characteristics were used for this comparative morphological study (Table 2). The result shows that these characteristics differ within this subfamily. Five characteristics such as shape of the parameres, ratio of length and width of parameres and shape of tergite VIII, etc., can be used to indentify tribes in the Spondylidinae. Six characteristics such as ratio of parameres and tegmen, shape of roof and curvature of median lobe, etc., can be used to identify genera in Asemini. Two characters, the ratio of length and width of parameres and the setation of tergite VIII can be used to identify species in the genus *Cephalallus* (Table 3).

Table 2. Characters used for morphological comparison

Characters	Abbreviation	Detail
Curvature	C1	Curvature of parameres bending to venter
	C2	Curvature of median lobe bending to venter
Ratio	R1	Ratio of length and width of parameres
	R2	Ratio of parameres and tegmen
	R3	Ratio of median structs and median lobe
	R4	Ratio of length and width of tergite VIII
	R5	Ratio of spiculum gastrale and dorsal plate
	R6	Ratio of spiculum gastrale and spiculum relictum
Shape	SH1	Shape of parameres
	SH2	Shape of ringed part in ventral view
	SH3	Shape of apical ventral edge of median lobe
	SH4	Shape of roof
	SH5	Shape of endophallus
	SH6	Shape of tergite VIII
	SH7	Shape of apex of tergite VIII
Setation	SE1	Setation of parameres
	SE2	Setation of tergite VIII
Present or Absent	P	Rod at apex of endophallus

Discussion

Length of the parameres and roof are relatively stable characteristics in Cerambycidae, and can be used for the classification in Cerambycidae (Ehara 1954). Our research suggests that the ratio of length and width of parameres is the most important character of the male genitalia in Spondylidinae. In addition, the shape of parameres, shape of tergite VIII, rod at apex of endophallus, and the setation of the tergite VIII are also functional as identifying characteristics among tribes of this subfamily from China.

Table 3. Comparison of male genital characters in Spondylidinae of China

Species	C1	SH1	R2	R1	SE1	SH4	SH2	C2	R3	SH3	SH5	P	SH6	R4	SH7	SE2	R5	R6
Atimia nadezhdae	slightly	robust	>1/4	3	apically	obvious, short	converging	prominently	3	sharply pointed	very thick	long					>1	
pondylis buprestoide	prominently	robust	>1/4	2.7	integrally	slightly differentiated	pyriform	prominently	2	bluntly pointed	very thick	absent	hexagon		nearly truncate	shorter in apical	>1	3
Tetropium gracilicorne	slightly	robust	>1/4	3	integrally	obvious, short	converging	prominently	1.1	strongly pointed	very thick	absent	semi-elliptical	>1	round	moderately uniform	>1	>2
Megasemum quadricostu–latum	moderately	slender	>1/4	4	integrally	obvious, short	constricted	prominently	3	bluntly pointed	slender	absent	ligulate	≈1	round	moderately uniform	>1	2
Asemum striatum	moderately	slender	<1/4	3.6	integrally	slightly differentiated	constricted	prominently	5	sharply pointed	moderate thick	absent	ligulate	>1	nearly truncate	moderately uniform	>1	≤2
Arhopalus foveatus	prominently	slender	>1/4	5	integrally	obvious, very short	converging	moderately	1	strongly pointed	very thick	absent	ligulate	>1	strongly concave	moderately uniform	>1	<2
Arhopalus rusticus	moderately	slender	≈1/4	4	integrally	obvious, very short	geniculated	prominently	3	weakly pointed	very thick	absent	ligulate	>1	round	moderately uniform	>1	3
Arhopalus angustus	slightly	slender	3/10	3	integrally	slightly differentiated	oblong	moderately	1	weakly pointed	moderate thick	absent	ligulate	≈1	Strongly concave	moderately uniform	>1	<2
Arhopalus coreanus	slightly	slender	3/11	5	integrally	obvious, short	slightly geniculated	prominently	5	weakly pointed	slender	absent	ligulate	>1	round	moderately uniform	>1	<2
Cephalallus unicolor	moderately	slender	≈1/4	5	integrally	absent ventrally, V-shaped dorsally	oblong	moderately	1.1	strongly pointed	slender	absent	ligulate	>1	concave	moderately uniform	>1	>2
Cephalallus oberthuri	moderately	slender	≈1/4	4	integrally	absent ventrally, V-shaped dorsally	oblong	moderately	1.1	strongly pointed	thick	absent	ligulate	>1	concave	longest in the dent	≈1	>2

Tetropium used to be placed in Asemini (Linsley 1962; Vives 2000; Ohbayashi & Niisato 2007). It is obviously different from Asemini in male genitalia, such as parameres robust and tergite VIII semi-elliptical, suggesting that it should be separated as a distinct tribe, and confirming the classification of Danilevsky (2014). *Cephalallus* was once regarded as a subgenus of *Arhopalus* based on external morphological characteristics (Gressitt 1951; Hayashi 1961; Gressitt & Rondon 1970; Pu 1992). According to the male genitalia characteristics such as shape of roof, shape of apex of tergite VIII, ratio of spiculum gastrale and spiculum relictum, our results show that it should be separated from *Arhopalus* as a distinct genus and this agrees with Ohbayashi & Niisato (2007) and Lim *et al.* (2014). Similarly, *Megasemum* was once placed as a subgenus of *Arhopalus* by Gressitt (1951), Shi (2012) reconstructed the phylogenetic relationships based on morphological characteristics, which also suggested *Megasemum* should be combined with *Arhopalus* as a subgenus. However, there are remarkable differences in male genitalia between them. For example, in *Megasemum* tergite VIII is always triangular, while in species of *Arhopalus* it is mostly ligulate. *Megasemum* and *Arhopalus* should be treated as two distinct genera (Linsley 1962; Ohbayashi & Niisato 2007; Danilevsky 2014).

In addition, the apical part of the endophallus with a sclerotization area in most species of Asemini is similar to that of some Lamiinae species (Ślipiński & Escalona 2013). This may suggest that the genetic relationship between Spondylidinae and Lamiinae is close, consistent with the viewpoint that Spondylidinae are sister to Lamiinae (Haddad *et al*. 2017). More evidence such as molecular data would be needed in further study.

Acknowledgements

Our hearty thanks are due to Mr. Wentao GAO (BHU), Ms. Yan LI (BHU), Ms. Hongui ZHAO (BHU), Ms. Wei XU (HICIQ), Mr. Hao XU and Mr. Zhiwei DONG for loaning specimens. We are also indebted to Mr. Yifan CHEN for the help in picture processing. Furthermore, we sincerely appreciate Ms. Xiaoyan YAN (SWU) for her valuable advice. This project was supported by the Science and Technology Basic Research Fund (2015FY210300).

References

Althoff J & Danilevsky ML. 1997. *A Check-List of Longicorn Beetles* (*Coleoptera, Cerambycidea*) *of Europe*. Slovensko entomološko društvo Štefana Michilija, Ljubljana, 64 pp.

Audinet-Serville JG. 1832. Nouvelle classification de la famille des longicornes. *Annales de la Société Entomologique de France*, 1(1): 118–201.

Audinet-Serville JG. 1834. Nouvelle classification de la famille des longicornes (suite). *Annales de la Société Entomologique de France*, 1(3): 5–110.

Aurivillius C. 1912. Cerambycidae: Cerambycinae. *Cerambycidae I*, 22(39): 2–39.

Bodemeyer GHE. 1927. Ueber meine entomologischen Reisen nach Kleinasien (1911), Ost–Sibirien, Schilka und Amur (1912), Tunis, Oasis Gafsa, Khroumerie (1913) und Iran, das Elbursgebirge (1914). Band III. Tunis, Oasis Gafsa und die Khroumerie Mit 2 Volltafeln: *Alfred Kernen Verlag*, 3: 43.

Casey TL. 1912. III–Studies in the Longicornia of North America. *Memoirs on the Coleoptera, Lancaster*, 3: 258–261.

Casey TL. 1924. Additions to the known Coleoptera of North America. *Memoirs on the Coleoptera*, 11: 227.

Chen B & Wu WW. 1986. A numerical taxonomic study of male genitalia of Cerambycidae (Coleoptera). *Journal of Southwest Agricultural University*, 3: 15–21.

Cherepanov AI. 1979. Subfamily Aseminae. *In*: Cherepanov AI (Ed.), *Longicorn beetle of North Asia* (*Prioninae, Disteniinae, Lepturinae, Ameminae*). Nauka, Movosibirsk, pp. 410–460.

Chiang SN. 1963. Results of the zoologico–botanical expedition to Southwest China, 1955–1957 (Coleoptera, Cerambycidae). *Acta Entomologica Sinica*, 12(1): 72.

Danilevsky ML. 2014. Spondylidinae. *In*: Danilevsky ML (Ed.), *Longicorn Beetles* (*Coleoptera, Cerambycidae*) *of Russia and Adjacent Counties. Part 1*. HSC, Moscow, pp. 358–390.

Degeer C. 1775. *Mémoires pour servir à l'Histoire des Insects. Tome cinquieme.* Imprimerie Pierre Hesselberg, Stockholm, 488 pp.

Ehara D. 1954. Comparative anatomy of male genitalia in some cerambycid beetles. *Journal of the Faculty of Science*, 12(6): 61–114.

Eschscholtz JF. 1830. Nova genera Coleopterorum Faunae Europaeae. *Bulletin de la Société Impériale des Naturalistes de Moscou*, 2: 66.

Fabricius JC. 1775. Systema Entomologiae, sistens insectorum classes, ordines, genera, species, adiectis synonymis, locis, descriptionibus, observationibus. *Flensburgi & Lipsiae: In Officina Libraria Kortii*: 159.

Fabricius JC. 1787. Mantissa insectorum sistens eorum species nuper detectas adiectis characteribus genericis, differentiis specificis, emendationibus, observationibus. *Hafniae, Proft*, 1: 152–154.

Feng B, Chen L & Wu GY. 2010. Study of male genitalia of species in the genus *Dorysthenes* (Coleoptera, Cerambycidae, Prioninae, Prionini). *Acta Zootaxonomica Sinica*, 35(1): 117–126.

Gahan CJ. 1906. *The Fauna of British India including Ceylon and Burma, Coleoptera, Vol.1 Cerambycidae.* Taylor and Francis, London, 37 pp.

Gmelin JF. 1790. Caroli a Linné Systema Naturæ per Regna tria Naturae, secundum Classes, Ordines, Genera, Species, cum characteribus, differentiis, synonymis, locis. Classis V. Insecta. Editio 13. *Lipsiae, Georg Emanuel Beer*, 1(4): 1846–1847.

Gressitt JL. 1951. Subfamily ASEMINAE. *In*: Gressitt JL (Ed.), *Longicornia, Longicorn Beetles of China, Vol. II*. Paul Lechevalier, Paris, ,pp. 31–43.

Gressitt JL & Rondon JA. 1970. Subfamily SPONDYLINAE. Subfamily ASEMINAE. *In*: Gressitt JL & Rondon JA (Eds.), *Cerambycid Beetles of Laos* (Disteniidae, Prioninae, Philinae, Aseminae, Lepturinae, Cerambycinae). Pacific Insects Monograph. Bishop Museum, Hawaii, pp. 24–26.

Haddad S, Shin S, Lemmon AR, Lemmon EM, Švácha P, Farrell B, Ślipiński A, Windsor D & Mckenna DD. 2017. Anchored hybrid enrichment provides new insights into the phylogeny and evolution of longhorned beetles (Cerambycidae). *Systematic Entomology*, 43(1): 68–89.

Haldeman SS. 1847. Material towards a history of the Coleoptera Longicornia of the United States. *Transactions of the American Philosophical Society*, 10(2): 35–56.

Hayashi M. 1961. The Cerambycidae from Amami–Ôshima Islands. I. Additions to the Cerambycid fauna of the Loochoo–Archipelago. 2 (Col.) *The Entomological Review of Japan*, 13(2): 35–46.

He SY, Liu ZP & Chen L. 2015. Comparative morphology study of the male genitalia in the tribe Astathini from China (Coleoptera: Cerambycidae). *Zoological Systematics*, 40(2): 197– 211.

Hua LZ. 2002. Cerambycidae. *In*: Hua LZ (Ed.), *List of Chinese Insects*. Zhongshan (Sun Yat-sen) University Press, Guangzhou, pp. 196.

Jiang SN & Chen L. 2001. *Fanua Sinica* (*Cerambycidae, Lepturinae*). Science Press, Beijing, 196 pp.

Kirby W. 1837. Fauna Boreali-Americana; or the zoology of the northern parts of British America: containing descriptions of the objects of natural history collected on the late Northern Land Expedition, under command of Captain Sir John Franklin, R. N. In J. Richardson, Swainson & Kirby. *Norwich, Josiah Fletcher*, 4: 174.

Klausnitzer *et al*. 2016. Cerambycidae volume 2: the central european species. 3., highly revised and extended edition. *In*: Klausnitzer B, Klausnitzer U, Wachmann E, Hromádko Z,*The longhorn beetles of central Europe.* Neue Brehm-Buecherei, 499(2): pp. 305–692.

Kraatz G. 1879. Ueber die Bockkäfer Ost–Sibiriens, namentlich die von Christoph am Amur gesammelten. *Deutsche Entomologische Zeitschrift*, 23(1): 97.

Kusama K & Takakuwa M. 1984. Subfamily Spondylinae. Subfamily Aseminae. *In*: Kusama K & Takakuwa M (Eds.), *The Longicorn-Beetles in Japan in Color.* The Japanese Society of Coleopterology, Kodansha, Tokyo, pp. 142–150.

Latreille PA. 1829. Suite et fin des insectes. *In:* G Cuvier (Ed.). *Le Règne Animal distribué d'après son organization,. pour servir de base a I 'histoire natureffe des animaux et d'introduction a I 'anatomie comparee. Nouvelle edition, revue et augmentee. Tome V.* Deterville, Paris, pp. 107.

LeConte JL. 1873. Classification of the Coleoptera of North America. Prepared for the Smithsonian Institution. Part II. *Smithsonian Miscellaneous Collections,* 11(265): 279–323.

Lee S, Yoo IS & Lee S. 2016. A new record of the tribe Atimiini LeConte (Coleoptera: Cerambycidae: Aseminae) in Korea. *Korean Journal of Applied Entomology*, 55(3): 303–307.

Lim J, Jung SY, Lim JS, Jang J, Kim KM, Lee YM & Lee BW. 2014. A review of host plants of Cerambycidae (Coleoptera: Chrysomeloidea) with new host records for fourteen Cerambycids, Including the Asian Longhorn Beetle (Anoplophora glabripennis Motschulsky), in Korea. *Korean Journal of Applied Entomology*, 53(2): 111–133.

Linnaeus C. 1758. *Systema Naturae per Regna Tria Naturae Secundum Classes, Ordines, Genera, Species, cum Characteribus, differentiis, Synonymis, Locis, 10th edition,* vol.1. Salviae, Holmiae, 824 pp.

Linsley EG. 1962. The Cerambycidae of North America. Part II. Taxonomy and Classification of the Parandrinae, Prioninae, Spondylinae & Aseminae. *University of California Publications in Entomology*, 19: 62–102.

Liu Y, Xiong S, Ren JQ, Zhang XX & Chen L. 2012. Comparative morphological study on genus *Batocera* (Coleoptera, Cerambycidae, Lamiinae, Batocerini). *Acta Zootaxonomica Sinica*, 37(4): 701–711.

Löbl I & Smetana A. 2010. Subfamily Spondylidinae. *In*: Löbl I & Smetana A (Eds.), *Catalogue of Palaearctic Coleoptera. Volume 6. Chrysomeloidea.* Apollo Books, Stenstrup, pp. 138–141.

Matsushita M. 1933. Beitrag zur Kenntnis der Cerambyciden des japanischen Reichs. *Journal of the Faculty of Agronomy of Hokkaido Imperial University, Sapporo*, 34(2): 157–445.

Monné MA. 1994. Catalogue of the Cerambycidae (Coleoptera) of the western hemisphere. Part XII. Subfamilies Parandrinae, Anoplodermatinae, Spondylinae, Aseminae, Oxypeltinae. *In*: Monné MA (Ed.), *Catalogue of the Cerambycidae.* Sociedade Brasileira de Entomologia, São Paulo, pp. 1–56.

Motschulsky VI. 1845. Remarques sur la collection de coléoptères russes de Victor de Motschulsky. *Bulletin de la Société Impériale des Naturalistes de Moscou*, 18(1): 1–127.

Motschulsky VI. 1860. Coléoptères rapportés de la Sibérie orientale et notamment des pays situées sur les bords du fleuve Amour par M.M. Schrenk, Maak, Ditmar, Voznessenski etc. *In*: Motschulsky VI (Ed.). *Reisen und Forschungen im Amur-Lande in den Jahren 1854-1856 im Auftrage der Kaiserlichen Akademie der Wissenschaften zu St. Petersburg ausgefohrt und in Verbindung mit mehreren Gelehrten herausgegeben. Band II. Zweite Lieferung. Coleopteren.* Eggers & Comp., St. Petersbur, pp 152.

Mulsant E. 1839. *Histoire Naturelle des Coléoptères de France. Longicornes*. Paris, Maison Libraire, Lyon, Imprimerie de Dumoulin, Ronet et Sibuet, 304 pp.

Nakamura S, Makihara H & Saito A. 1992. Check-list of Longicorn-Beetles of Taiwan. *Miscellaneous Reports of the Hiwa Museum for Natural History*, Shobara, 33: 4–8.

Napp DS. 1994. Phylogenetic relationships among the subfamilies of Cerambycidae (Coleoptera-Chrysomeloidea). *Revta bras Ent*, 38(2): 265–419.

Nonfried AF. 1892. Verzeichniss der um Nienghali in Südchina gesammelten Lucanoiden, Scarabaeiden, Buprestiden und Cerambyciden, nebst Beschreibung neuer Arten. *Entomologisches Nachrichtenblatt, Troppau*, 18: 85–92.

Ohbayashi N & Niisato T. 2007. *Longicorn Beetles of Japan.* Tokai University Press, Kanagawa, 818 pp.

Okamoto H. 1927. The Longicorn Beetles from Corea. *Insecta Matsumurana, Sapporo*, 2(2): 63.

Özbek H, Özdikmen H & Aytar F. 2015. Contributions of the longhorned beetles knowledge of Turkey by the subfamilies Aseminae, Saphaninae, Spondylidinae, Cerambycinae and Stenopterinae (Coleoptera: Cerambycidae). *Munis Entomology & Zoology*, 10(1): 291–299.

Özdikmen H. 2014. Turkish red list categories of longicorn beetles (Coleoptera: Cerambycidae) Part IV–Subfamilies Necydalinae, Aseminae, Saphaninae, Spondylinae and Apatophyseinae. *Munis Entomology & Zoology*, 9(1): 440–450.

Pic M. 1901. Notes diverses et diagnoses [2e article]. *L'Échange, Revue Linnéenne*, 17(194): 11.

Pic M. 1902. Notes diverses et diagnoses. *Matériaux pour servir à l'étude des Longicornes*, 4(1): 8–11.

Pic M. 1916. Notes diverses, descriptions et diagnoses (Suite.). *L'Échange, Revue Linnéenne* 32, (375): 9–11.

Plavilstshikov NN. 1915. Zhuki–usachi, sobranye A.I. Aleksandrovym v Manchzhurii (Col., Cerambycidae). *Entomologichesky Vestnik, Kiev*, 2(2): 103–110.

Pu FJ. 1992. Coleoptera: Disteniidae and Cerambycidae. *In*: Chen S (Ed.), *Insects of the Hengduan Mountains Region*, *Volume 1*. Science Press, Beijing, pp. 588–623..

Reitter E. 1889. Neue Coleopteren aus Europa, den angrenzenden Ländern und Sibirien, mit Bemerkungen über bekannte Arten. Siebenter Theil. *Deutsche Entomologische Zeitschrift*, 33(2): 287–288.

Ren CL, Chen L & Li Z. 2016. Comparative morphology study of the male genitalia of the genus *Aegosoma* from China (Coleoptera: Cerambycidae), with a new record species. *Zoological Systematics*, 41(4): 415–426.

Seidlitz GCM. 1891. Gattungen. *In*: Seidlitz GCM (Ed.), *Fauna Transsylvanica. Die Kaefer* (*Coleoptera*) *Siebenbürgens.* Hartung, Königsberg, pp.178–180.

Serafim R. 2007. The catalogue of the Palaearctic species of Spondylidinae (Coleoptera: Cerambycidae) from the patrimony of "Grigore Antipa" Nation Museum of Natural History (Bucharest) (Part III). *Travaux du Muséum National d'Histoire Naturelle.* Vol. L. 221–230.

Sharp D. 1905. The genus *Criocephalus*. *Transactions of the Entomological Society of London*, 1905: 148–164.

Shi SQ. 2012. *Systematics of Aseminae and Disteniidae from China.* Southwest University, Chongqing, 74 pp.

Ślipiński A & Escalona E. 2013. *Australian Longhorn Beetles (Coleoptera: Cerambycidae).* ABRS, Canberra. 484 pp.

Švácha P & Lawrence JF. 2014. Coleoptera, Beetles.Volume 3: Morphology and Systematics (Phytophaga). *In*: Švácha P & Lawrence JF (Eds.), *Handbook of Zoology. Arthropoda: Insecta..* De Gruyter, Berlin, pp.16–177.

Thomson J. 1861. Group. ASEMITAE. Group. SPONDYLITAE. *In*: Thomson J (Ed.), Essai d'une classification de la famile des Cerambycides et materiaux pour servir a une monographie de cette famille. Société Entomologique de France, Pairs, pp. 259–272.

Tsherepanov AI & Tsherepanov NE. 1973. Novij rod i vid drovoseka (Col., Cerambycidae) dlja fauny SSSR. Taksonomiya i Ekologiya Chlenistonogikh Sibiri. *Nauka, Novosibirsk*, 7: 80–81.

Vives NE. 2000. Coleoptera Cerambycidae. *Fauna Ibérica*, 12: 94–110.

Wang Q. 2017. General Morphology, Classification, and Biology of Cerambycidae. Subfamily Spondylidinae. *In*: Monné ML, Monné MA & Wang Q (Eds.). *Cerambycidae of the World: Biology and Pest*

Management, (1) CRC Press, Boca Raton, pp. 64–66.

Wang WK. 2002. A comparative anatomical study on the male genitalia of *Xylotrechus* (Cerambycoidea: Cerambycinae: Clytini). *Journal of Hubei Agricultural College*, 22(3): 202– 205.

Zhang XX & Chen L. 2013. Comparative morphological study on the genus *Demonax* (Coleoptera, Cerambycidae, Clytini). *Acta Zootaxonomica Sinicam*, 38(4): 714–734.